THE

AMERICAN NATURALIST.

Vol. V.—AUGUST, 1871.—No. 6.

THE STUDY OF MINUTE FUNGI.

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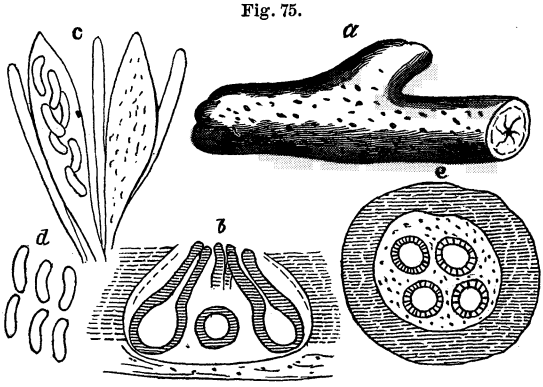
THERE are probably a number of microscopists, or, perhaps it would be better to say, possessors of microscopes in this country, who would gladly turn their attention to the minute Fungi, if they only knew how to begin, or could obtain any one book or treatise which would furnish the necessary guidance. As there is no such book in existence, the literature of Mycology being confused and scattered in the highest degree, it may be that a few words of advice as to the best mode of study of this subject will be of some interest.

As a text for my remarks, I will take one of the commonest of the minute Fungi, which can be found everywhere and at all times of year, namely, *Valsa stellulata* Fr. The Valsæ form a genus of the great order Sphæriacei, which in their various states comprise the majority of the black specks or dots which will be found upon almost all decaying wood, and dead twigs, leaves, and herbaceous stems. To obtain specimens, you need only step into the yard and examine minutely a few twigs, pieces of old board, or dead stems of flowers or weeds, on some of which you will be certain to find little black, shot-like bodies, varying in size, from that of a large pin's head to a mere point hardly perceptible to the naked eye, while half an hour's stroll in the woods, and an examination of two or three decaying stumps or logs, and some of the

dead branches lying about, and especially an overhauling of one of the little piles of drift wood about the roots of some tree on the bank of a creek, will furnish you material for a year's work, if properly used. On one or more of the branches you have picked up you will find a portion thickly dotted with black spots, which, under a hand magnifier will be seen to be little black bodies, closely united and bursting through the bark. These are really the ends of as many tubes, which are the necks of globular, oval or retort-shaped flasks buried in the bark or wood beneath. By slicing off with a sharp knife, thin horizontal sections of the bark, through one or two of these little pustules, you will be able to see these flasks in situ very distinctly. Probably they will appear black and empty with thick walls.

Fig. 75.



a, Valsa on a fragment of branch, natural size. *b*, perpendicular section. *c*, Asci and paryphyses. *d*, spores. *e*, horizontal section of conceptaculum and perithecia.

With the point of a knife pick out one or two of these flasks, put them on a glass slide with a drop of water, and a rather thick cover, and crush them out flat by pressure. Examination of the object thus prepared, with a power of about two hundred and fifty diameters, will show that the contents of the flasks are little colorless delicate sacs, in each of which are eight minute colorless, curved, sausage shaped spores.

The little sacs are called thecæ, or more usually asci, the flask which encloses them being called the perithecium. And the Sphæriacei are Fungi in which the spores are contained in asci (ascomycetes) and the asci are produced in perithecia, which are more or less globose, at first entirely closed, at length opening by a neck (ostiole), or pierced by a small hole or pore at the summit. If each perithecium is by itself, or solitary, not imbedded in a crust or stroma, but either on, or in the bark or wood, it is called a simple or true Sphæria.

If the perithecia are associated in little clusters of from two to twenty, imbedded in the bark or wood, with long necks which converge to form a bundle or disc which pierces the bark, it is a *Valsa*. If the perithecia are buried in a brown or black carbonaceous mass or stroma, which grows like a cushion *on* the bark, the necks of the perithecia being short and not converging, it belongs to the genus *Hypoxylon*. If this stroma is more developed, growing up like a miniature club from one to four inches high, black or brown, corky or brittle, with the perithecia immersed in it at the upper part, it forms the genus *Xylaria*. If this club or stalk be fleshy, white or red it is a *Cordyceps*. This genus for the most part grows up from dead caterpillars or insects, giving rise to the newspaper stories of the vegetable bug.

Let us now return to our Valsa. Having determined that it is a Valsa, we next wish to know its specific name. And, just at this point is where the great difficulty in the study of mycology commences, where the student is most apt to be discouraged and demoralized, and where a little assistance is most needed. To determine the species of a Valsa we must first ascertain whether the perithecia are in a special stroma, and next whether this stroma has a distinct limiting wall or conceptaculum.

If there is a black, ventricose conceptaculum, pyriform or conoidal in shape, the apex being upwards, with the perithecia scattered through the stroma, and their long converging necks bursting through the conceptaculum, and then through the bark, it belongs to the subdivision *Circumscriptæ*. Slicing across one of the pustules of our Valsa, and examining the cut surface we see a black ring; the cut edge of the conceptaculum, within which is a spongy mass, the stroma, in which are the perithecia. Of the *Valsæ circumscriptæ*, about forty species have been described by mycologists. To decide which of these species you have before you, you next examine the spores. About a dozen species have spores like those described above, namely, colorless curved rods. Your next step, then, is to ascertain accurately the length of the spores before you. And by "accurately" I mean that you should determine their length to within the $\frac{1}{1000}$ of an inch. The easiest way to do this, is by means of an eye-piece micrometer, but if you have not this you must rule a scale on a card by aid of your stage micrometer and camera lucida.

On a line across one end of the card, mark off the length of

three or four one-thousandths of an inch as they appear through the camera. At each of these points draw a line perpendicular to the base. The most convenient length for these lines is $2\frac{1}{2}$ inches. Now divide these lines into ten equal parts, by lines ruled parallel to the base line, and then draw a line diagonally from one of the $\frac{1}{1000}$ inch marks on the base line to the next $\frac{1}{1000}$ inch mark in the tenth line above. You will thus have constructed a diagonal scale which will measure to the ten-thousandth of an inch. To use it, you lay it on the stage beside the object, and view it with one eye and the object with the other. You will with a very little practice see the object projected on the card and can read off its length at once.

On measuring the spores of your specimen, you find that they are .0004 of an inch long. The spores of all the species in this division of the Valsæ are shorter than this, with the exception of *Valsa stellulata* Fr. Fr. stands for Fries, a great Swedish mycologist who named and described this species and this is his description.

"*S. stellulata.*—Subrotunda, immersa, stromata albo circumscripto, ostiolis ovato globosis, brevibus radiato stellatis" . . . The "Systema Mycologicum" of Fries from which the above description is taken, was published in 1822, and, of course, at that time there was no microscope at his command by which he could define the fruit. The first description of the spores of this species was given by De Notaris, in 1853, in the Memoirs of the Academy of Science in Turin.

But the mere giving a name to our fungus, or finding out what name somebody else has given to it, amounts to very little, except as giving the same sort of mental exercise and amusement, as the putting together a puzzle of any kind would do. What we want to know, is, how did the Valsa get there under the bark? What is its life history, and what is its use or purpose, if it has any? And the first question of all to occur to you, if you have become a little impatient of the very minute points by which one of the so-called species differs from another is, how do you know that these points indicate specific differences? In other words why do you practically assert that the fungus with spores exactly like, but with spores the one ten-thousandth of an inch shorter than another fungus, may not be merely a stunted specimen of the latter? To the latter query I must reply, that at present we have no satis-

factory basis on which to discriminate species in the minute Fungi, and this is true even as regards some genera, and it is with a faint hope that some of my readers will aid in establishing such a basis that I have called their attention to this subject. The practical test of a good species is, that it will produce its like, subject to variations which are usually limited in degree. Now this test has not been applied to any of the species of Valsa, nor, indeed, to any of the Sphæriacei; and the observer who will take a specimen of *Valsa stellulata* or of any other species, and propagate it, watching its development under varying conditions of place, moisture and temperature, and honestly and accurately report the results, will do more to advance our knowledge of these plants than if he had collected and ticketed a thousand or two of them. This field is almost entirely unexplored, and I know of no reported results of culture of any of the Sphæriacei. All that has been done has been in a few cases to observe the succession of forms and to conclude on the principle of "post hoc ergo propter hoc" that these forms necessarily belong to the same plant.

That some of the minute Fungi in the various stages of their development assume different forms—so much so that these forms have been classed under different orders and classes, there is no doubt—but in very few cases have these various stages been made out with anything like precision. The Brothers Tulasne, in the second volume of their great work, the "Selecta Fungorum Carpologia," attempt to specify the various stages and forms of the Sphæriacei—and upon these to base a new system of classification. Splendid as is their work, it will very soon be manifest to any one who attempts to make use of it to classify species which they have not named—and although the book is a thick quarto, it does not refer to one-tenth part of the forms known—that it will afford him little or no assistance.

The attempt at a physiological classification of these organisms is as yet premature, the mere morphological classification being still so very incomplete, that it is impossible from published descriptions to identify much more than half of the minute Fungi which have been described, while a vast number have been collected and named which have never been described at all. I do not, therefore, recommend the microscopist who proposes to undertake this study, to try to do more at first than to recognize genera, and I furthermore advise him to confine his work for a

time to half a dozen species which he can get named for him by some one who has the necessary facilities for so doing in the shape of identified specimens. For instance, having ascertained that he has a specimen of *Valsa stellulata*, let him first see whether he can get the spores to germinate. First, he may try them with a little water on some form of growing slide, the simplest form of which is to take the slide with the spores on it covered with a piece of thin glass just as he has been examining it under the microscope, and laying it across a narrow dish of water (a soap dish or toothbrush dish is just the thing) let two or three threads lead from the water to the edge of the thin glass cover. The growing slides of Hoffman, De Bary, Dr. Maddox, and those described by Dr. Curtis and the author in their report on Fungi in connection with the Texas cattle fever, are all good and useful. The spores should be tried not only in water, but in fluids which will afford them some nutriment, such as juice of fruits or plants, Pasteur's fluid, or on such media as a slice of potato, blotting paper soaked in lemon juice, etc., etc.

But the most essential, and what will prove to be the most interesting, experiments will be the culture of the fungus in its native habitat, viz., on, or in the small branches of the tree on which it is found. Cut off a small branch of oak and cut it into lengths, say a foot long. Examine these carefully to make sure that the bark is smooth and unbroken, and then on half a dozen of these pieces plant your Valsa by placing it both on and under the bark at marked points. Plant the same Valsa in like manner on similar pieces of branches from other trees, for instance, elm, beech, and blackberry or green-brier (Smilax) or on the grape-vine. For purposes of comparison, keep half a dozen similar pieces of each kind of wood without planting anything on them. Now place your pieces of wood, two of them in a miniature hot-bed, two of them under glass over water, and two of them simply on the ground in the open air, where they will not be disturbed. Observe that wherever you put a planted specimen, you must put an unplanted branch of the same wood under the same circumstances.

Having planted this new kind of garden you have to watch for results. If the theories of Tulasne are correct you ought to find, preceding the true Valsa, little perithecia which however will contain no asci, but minute colorless bodies embedded in a sort of

gelatine which have an active swarming motion when placed in water, and which he calls spermatia; these he says will not germinate, but I advise you to try for yourself. These bodies are usually referred to the genus Cytispora or Næmaspora, belonging to a totally different order of Fungi, the Sphæronemei of the Coniomycetes. You will probably also find various moulds appearing on the sticks, some of which are very curious, and have received very long and hard names, and your experience will differ from mine if you do not find a number of forms which you will not expect and which will puzzle you very much. Note and draw them all, and combine your results in a paper for the NATURALIST, which shall give the life history of the particular Hypoxylon, Diatrype, Valsa or Sphæria, with which you have experimented.

The field is very wide, and the experiments of one man must be checked by those of another to get our knowledge of the subject established upon a satisfactory basis.

I feel sure that any one who gets fairly started in this field of investigation will find it infinitely more amusing, interesting and satisfactory than looking at specimens purchased ready mounted and labelled.

There is another, and the usual mode of studying this subject, namely, the collecting all the specimens you can get and having ascertained their specific names put them in an herbarium. This kind of work very few can have the necessary facilities for doing, for it is absolutely necessary to have access to authentic specimens and good libraries to obtain valuable and satisfactory results. It is work which must be done by somebody, but it involves a good deal of uninteresting labor, and is not at present so desirable as the mode of investigation which I have indicated.

THE TOAD AS AN ENTOMOLOGIST.

BY A. S. RITCHIE.

THE principal object of the following notes on the toad as a collector of beetles, is to show how useful some of the lower animals are to man in his search after knowledge. Before entering on the